Feb. 14, 1939. D. E. DASHER 2,146,797

REFRIGERATING APPARATUS

Filed May 20, 1937

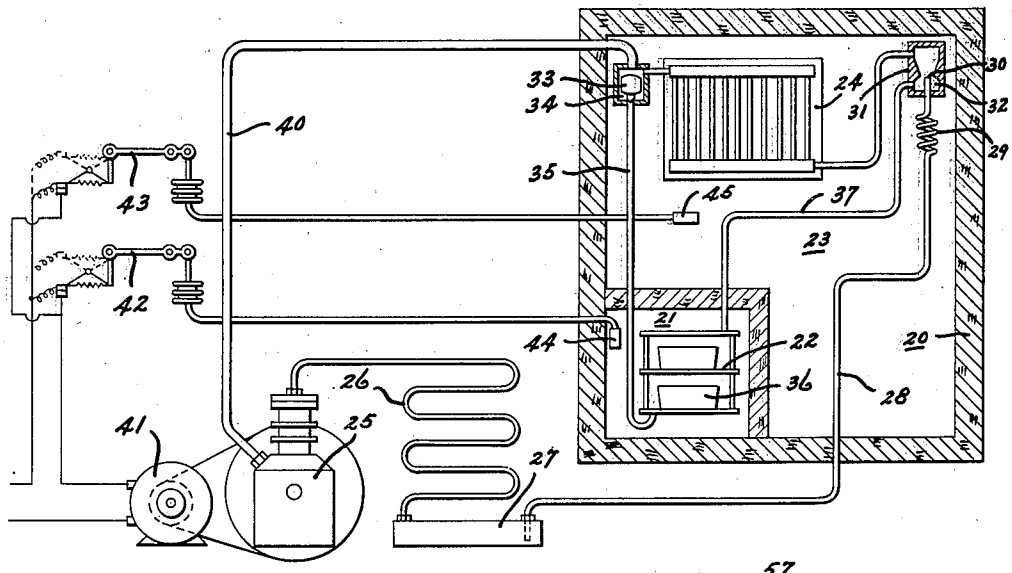


Fig. 1

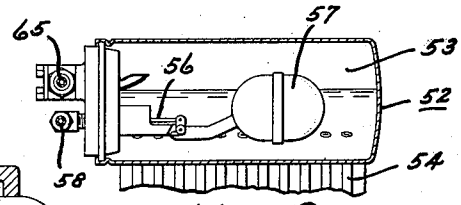


Fig. 3

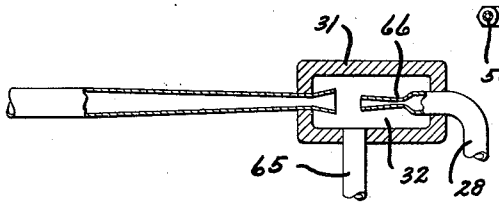


Fig. 4

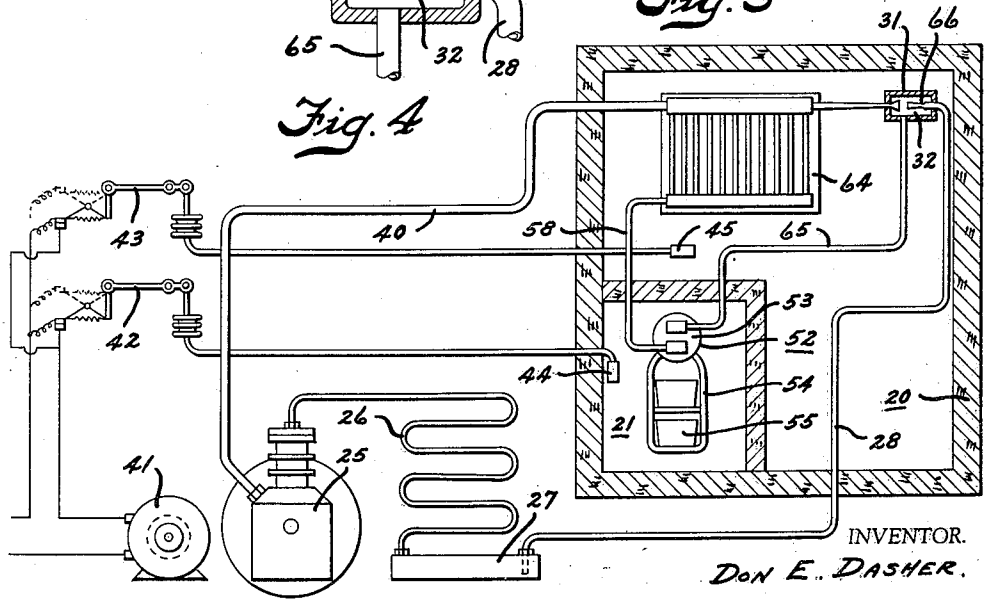


Fig. 2

INVENTOR.
DON E. DASHER.

BY
Spencer, Wardman and Fehr.
HIS ATTORNEYS.

Patented Feb. 14, 1939 2,146,797

UNITED STATES PATENT OFFICE

2,146,797

REFRIGERATING APPARATUS

Don E. Dasher, Dayton, Ohio, assignor to General Motors Corporation, Dayton, Ohio, a corporation of Delaware

Application May 20, 1937, Serial No. 143,842

12 Claims. (Cl. 62—115)

This application is a continuation in part of my copending application Serial No. 727,514, filed May 25, 1934, and relates to refrigerating apparatus and particularly to two-temperature refrigerating systems.

Heretofore household refrigerators and other refrigerating apparatus employing but a single refrigerating system have had evaporating means operating at a single evaporating temperature and pressure range. In these and other compression refrigerating systems the energy of the liquid refrigerant in flowing from the high to the low side of the system has not been utilized for other purposes and has been wasted. It is therefore an object of my invention to utilize this energy to create other evaporating pressures for providing a more efficient refrigerating process and appartus.

Another object of my invention is to provide an improved type of multiple temperature refrigerating system capable of maintaining a plurality of evaporating pressures without loss of efficiency wherein only one suction line is required to connect the compressor with the evaporating means for withdrawing evaporated refrigerant.

A further object of my invention is to provide an improved and more efficient refrigerating system for household refrigerators and the like employing a plurality of evaporators functioning at different evaporating pressures and temperatures relative to one another and to provide an improved refrigerant control in which a controlled flow of liquid refrigerant is provided from one evaporator to another.

In carrying out the foregoing objects it is a still further and more specific object of my invention to provide a refrigerating system wherein liquid refrigerant pre-cooled in one evaporator maintained at a predetermined high temperature is conveyed into another evaporator and to utilize the energy of liquid refrigerant flowing into the high temperature evaporator for maintaining the said another evaporator at a relatively lower temperature for freezing purposes.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawing, wherein a preferred form of the present invention is clearly shown.

In the drawing:

Fig. 1 is a diagrammatic showing of a two-temperature household refrigerator and refrigerating system associated therewith embodying my invention;

Fig. 2 is a diagrammatic view similar to Fig. 1 and illustrates a modified form of refrigerating system embodying my invention and associated with a refrigerator adapted to have two different temperatured compartments therein;

Fig. 3 is an enlarged vertical sectional view through a portion of the low temperature evaporator employed in the system disclosed in Fig. 2; and

Fig. 4 is an enlarged sectional view of a jet apparatus employed in the system disclosed in Fig. 2.

Referring to the drawing, and more particularly to Fig. 1, there is shown diagrammatically an insulated refrigerator cabinet **20** having an insulated freezing compartment **21** containing a freezing or low temperature evaporating means **22** and an insulated food storage compartment **23** containing a high temperature evaporator **24**. The evaporators **22** and **24** are supplied with liquid refrigerant by a refrigerant liquefying apparatus including a compressor **25** for compressing the refrigerant and for pumping the compressed refrigerant into a condenser **26** where the compressed refrigerant is liquefied and collected in a receiver **27**. From the receiver **27**, the liquid refrigerant is forwarded through a supply conduit **28** under the control of a suitable control device such a restrictor **29** which is provided with a nozzle **30** located within a Venturi tube **31**.

The restrictor **29** and the nozzle **30** change the pressure energy of the liquid refrigerant into a velocity energy and discharge a stream of liquid into the venturi at a high velocity. This forms a jet pump which pumps vapor from the suction chamber **32** of this jet Venturi means. The nozzle **30** may be moved parallel to the axis of the Venturi tube in order to vary the pumping effect of this jet. The liquid refrigerant discharged from the nozzle **30** of the jet pump flows into the high temperature evaporator **24**. The restrictor **29** is preferably of tubular form of a predetermined length and having a small bore or passage therethrough. However, restrictors of the type suitable for use in the system disclosed are well known to those skilled in the art and it is to be understood that I may employ other conventional restrictors such as valves, etc., without departing from the invention.

When the high temperature evaporator **24** is filled with liquid refrigerant up to a predetermined level, surplus and pre-cooled liquid refrigerant flowing from evaporator **24** into the float chamber **34** causes float valve **33** within chamber **34** to be lifted to open the valve and permit the

liquid refrigerant to flow through the tubing 35 into the lower portion of the freezing evaporator 22. The liquid refrigerant within the freezing evaporator 22 evaporates and absorbs heat from any water in the ice trays 36 and the ambient air within the freezing compartment and this evaporated refrigerant is removed, by virtue of the effect produced by the jet pump, through the tubing 37 connected to the suction chamber 32 of the jet pump which creates a substantially lower evaporating pressure in the freezing evaporator 22 than in the high temperature evaporator 24.

The liquid refrigerant within the high temperature evaporator 24 evaporates and absorbs heat from the ambient air within the food compartment 23 and this evaporated refrigerant is withdrawn from the top of the float chamber 34 through the return conduit 40 which is connected to the inlet of the compressor 25. The compressor 25 is driven by an electric motor 41 which is connected in series with the snap acting switches 42 and 43 which are connected in parallel electric circuit relation with each other and which are controlled respectively by the thermostatic bulb 44 located within the freezing compartment 21 and the thermostatic bulb 45 located within the food storage compartment 23. Thus, when refrigeration is required in either of these compartments, the compressor is caused to operate so as to supply refrigeration thereto. However, if desired, the switches 42 and 43 may be placed in series so that the refrigerating system will operate only when both of the compartments require refrigeration.

By employing the jet pump means operated by the pressure difference between the pressure of the liquid refrigerant in the receiver or high side of the refrigerating system and the pressure within the high temperature evaporator 24, a substantially lower evaporating pressure and temperature is created within the freezing evaporator 22 than in the high temperature evaporator 24 without the use of additional energy. In addition to this gain in efficiency by the use of the two evaporators, one for freezing purposes and one for cooling the food storage compartment, the high temperature evaporator 24 may operate at a much higher evaporating pressure and temperature than when only one evaporator operating within a single pressure range is employed for both the freezing of ice cubes and comestibles, as well as for cooling the food storage compartment. This enables the compressor 25 to operate at a higher back pressure than customary with household refrigerating systems employing but a single evaporator and this, of course, reduces the load upon the compressor 25 of the electric motor 41, because the pressure difference between the refrigerant pressure on the inlet side of the compressor and that on the outlet side of the compressor is considerably less.

This system also permits the freezing evaporator to be operated at lower temperatures than is customary where a single evaporator is employed for both freezing and box cooling purposes. As a result of this, freezing can be done much more quickly in a refrigerator of this type than in those now commonly used. By operating the food storage compartment evaporator at a high temperature, which, of course, is below the desired food compartment temperature, a relatively high humidity may be maintained within the food storage compartment 23 and dehydration of foods and particularly dehydration of vegetables may be avoided.

In Fig. 2 there is disclosed an apparatus similar to that shown in Fig. 1 and embodying the principles of my invention in a slightly modified form of refrigerating system. In this showing of my invention the low temperature evaporator 52 is of conventional construction and includes a header 53 having refrigerant expansion tubes or pipes 54 depending therefrom. The refrigerant expansion pipes 54 may be formed between a double sheet metal wall structure as is now common in the art and the refrigerating wall may be formed to provide a freezing compartment or compartments for the reception of ice trays 55. The upper part of evaporator 52 is preferably constructed in accordance with the type of evaporator disclosed in the patent to Osborne 1,556,708, Oct. 13, 1925, wherein header 53 is supplied with liquid refrigerant under the control of a valve 56 actuated by a float 57 (see Fig. 5) which is responsive to the level of liquid refrigerant in evaporator 52. A conduit 58 is connected with the lowermost portion of the high temperature evaporator 64 and conducts liquid refrigerant precooled in the evaporator 64 to the low temperature evaporator 52 under control of valve 56. A conduit 65 communicates with the interior of header 53 of evaporator 52 and is connected with the low pressure or suction chamber 32 of the jet Venturi means for withdrawing gaseous refrigerant evaporated in evaporator 52 therefrom. The jet Venturi means or apparatus in this modified system comprises a combined nozzle or jet and restrictor 66 and this combined element may be assembled into the end of conduit 28 or may be formed by the conduit in the end thereof. The combined jet or nozzle and restrictor 66 in this form of the invention eliminates the use of a separate restrictor such as the restrictor 29 disclosed in Fig. 1. Combined jet or nozzle and restrictor 66 is located in the Venturi means or diffuser 31 in the relation shown in Fig. 6 of the drawing and this showing comprises a conventional jet apparatus well known to those skilled in the art. For reasons to be hereinafter more fully described this jet apparatus need not be of special construction because the demands placed upon same in the present invention are not beyond the usual demands placed upon such a device. The conduit leading from the jet Venturi pump means or diffuser to evaporator 64 is connected with the upper part of evaporator 64. The jet pump apparatus or diffuser is preferably disposed above the level of the body of liquid refrigerant maintained in evaporator 64. The form of refrigerating system disclosed in Fig. 3 insures that the low temperature evaporator 52 will at all times contain liquid refrigerant up to a certain level without flooding the conduit 65 and the jet apparatus and this feature renders this system practical and more effective for freezing water in trays 55 of evaporator 52 than the system disclosed in Fig. 1.

From the foregoing it will be seen that the energy of the compressed liquefied refrigerant is converted into velocity energy and that this velocity energy is utilized to withdraw evaporated or gaseous refrigerant from the low temperature evaporator. The velocity energy of liquid refrigerant flowing from the end of the liquid refrigerant supply pipes 28 and the immediate flashing into vapor of a part of the flowing liquid refrigerant provides energy inherent in the systems which is utilized, without loss of efficiency, to

create a lower pressure in the freezing evaporators than in the air cooling evaporators. The feeding of pre-cooled liquid refrigerant from the high temperature evaporator to the low temperature evaporator of the systems disclosed is advantageous because it requires less vapor to be drawn from the low temperature evaporators by the diffuser or jet pump apparatus to thereby reduce the demands on this apparatus and to permit a jet pump of ordinary and conventional construction to be employed. By my improvement the expansion of liquid refrigerant to one evaporator is utilized for lowering the pressure of vapor from another evaporator in the system. In the systems disclosed the energy of cooling the liquid refrigerant flowing to one evaporator is used to produce a lower temperature of refrigeration in another evaporator and this energy is therefore not wasted as has been the case prior to my invention. Since the present invention utilizes the velocity of liquid refrigerant flowing through a nozzle in a jet Venturi apparatus or diffuser and particularly flashing of a part thereof into vapor as it passes through the nozzle, for producing energy to reduce the pressure in the suction chamber of the jet apparatus, it is essential that the jet apparatus or diffuser be interposed in the liquid refrigerant conduit extending from the receiver.

While the forms of embodiment of the invention as herein disclosed, constitute preferred forms, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. The process of refrigeration which comprises withdrawing evaporated refrigerant from an evaporating space, compressing the evaporated refrigerant and cooling the compressed evaporated refrigerant to liquefy same, converting the energy of the liquefied refrigerant into velocity energy, utilizing the velocity energy to withdraw evaporated refrigerant from a second evaporating space and to create a lower pressure within the second evaporating space than in the first mentioned space, discharging the refrigerant withdrawn from the second evaporating space into the first mentioned evaporating space, causing liquid refrigerant to flow from said first mentioned evaporating space into the second evaporating space and controlling said flow automatically in response to conditions of said second evaporting space.

2. The process of refrigeration which comprises withdrawing evaporated refrigerant from an evaporating space, compressing the evaporated refrigerant and cooling the compressed evaporated refrigerant to liquefy same, converting the energy of the liquefied refrigerant into velocity energy, utilizing the velocity energy to withdraw evaporated refrigerant from a second evaporating space and to create a lower pressure within the second evaporating space than in the first mentioned space, and conducting and separately controlling the flow of liquid refrigerant from said first mentioned evaporating space into the second evaporating space.

3. The process of refrigeration which comprises withdrawing evaporated refrigerant from an evaporating space, compressing the evaporated refrigerant and cooling the compressed evaporated refrigerant to liquefy same, converting the energy of the liquefied refrigerant into velocity energy, utilizing the velocity energy to withdraw evaporated refrigerant from a second evaporating space and to create a lower pressure within the second evaporating space than in the first mentioned space, discharging the refrigerant withdrawn from the second evaporating space into the first mentioned evaporating space, and conducting and separately controlling the flow of liquid refrigerant from said first mentioned evaporating space into the second evaporating space.

4. Refrigerating apparatus including a plurality of evaporators, means for supplying liquid refrigerant to and for withdrawing gaseous refrigerant from said evaporators, means for conducting liquid refrigerant pre-cooled in one of said evaporators therefrom and controlling its entrance into another of said evaporators, and means utilizing the energy of refrigerant flowing from said supply means to said one of said evaporators for creating a substantially lower evaporating pressure within said another evaporator than in said one evaporator.

5. Refrigerating apparatus including a plurality of evaporators, means for supplying liquid refrigerant to and for withdrawing gaseous refrigerant from said evaporators, means for conducting liquid refrigerant pre-cooled in one of said evaporators therefrom and controlling its entrance into another of said evaporators, and means utilizing the energy of refrigerant flowing from said supply means to said one of said evaporators for creating a substantially lower evaporating pressure within said another evaporator than in said one evaporator, means responsive to the temperature produced by one of said evaporators for controlling the operation of said refrigerant supplying and withdrawing means.

6. Refrigerating apparatus including a plurality of evaporators, means for supplying liquid refrigerant to and for withdrawing gaseous refrigerant from said evaporators, means for conducting liquid refrigerant pre-cooled in one of said evaporators therefrom and controlling its entrance into another of said evaporators, and means utilizing the energy of refrigerant flowing from said supply means to said one of said evaporators for creating a substantially lower evaporating pressure within said another evaporator than in said one evaporator, means responsive to the temperature produced by either of said evaporators for controlling the operation of said refrigerant supplying and withdrawing means.

7. Refrigerating apparatus including a plurality of evaporators, means for supplying liquid refrigerant to one of said evaporators, said supply means including means for supplying said liquid at a higher pressure than the pressure within another of said evaporators and for creating a lower pressure within said another of said evaporators, means for conducting liquid refrigerant from said one evaporator to said another evaporator, and means energized by the flow of liquid refrigerant from said supply means to said one evaporator for creating a substantially lower evaporating pressure within the said another evaporator than in said one evaporator.

8. Refrigerating apparatus including a condenser and a plurality of evaporators, a compressor for pumping refrigerant from the evaporators to the condenser and creating a higher pressure in the condenser than in the evaporators, said refrigerant being liquefied in the condenser, means for conducting and controlling the flow of liquid refrigerant from the condenser to one of the said evaporators, and means for

supplying liquid refrigerant from said one evaporator to another of said plurality of evaporators, said conducting and controlling means including pumping means energized by the pressure energy of the liquid refrigerant for creating a pressure difference between the plurality of the evaporators greater than the hydrostatic pressure difference therebetween.

9. The process of refrigeration which comprises withdrawing evaporated refrigerant from an evaporating space, compressing the evaporated refrigerant and cooling the compressed evaporated refrigerant to liquefy the refrigerant, converting the energy of the liquefied refrigerant into velocity energy, utilizing the velocity energy to withdraw evaporated refrigerant from a second evaporating space and creating a lower pressure within the second evaporating space than in the first mentioned space, discharging the refrigerant into the first mentioned evaporating space, and conducting and separately controlling the flow of liquid refrigerant from said first mentioned evaporating space into the second evaporating space.

10. Refrigerating apparatus including a low temperature and a high temperature evaporator, a condenser and a compressor for pumping evaporated refrigerant from one of said evaporators into the condenser and creating a higher pressure within the condenser, said refrigerant being liquefied in the condenser, means for conducting and controlling the flow of liquid refrigerant to said evaporators, said means including separate means for restricting the flow of liquid to the low temperature evaporator, said conducting and controlling means including pumping means energized by the pressure energy of the liquid refrigerant for creating with the aid of the separate restricting means a lower evaporating pressure within the low temperature evaporator than in the high temperature evaporator.

11. A refrigerator having separate freezing and food compartments, a low temperature evaporator in heat exchange relation with the freezing compartment and a high temperature evaporator in heat exchange relation with the food compartment, a condenser and a compressor for pumping evaporated refrigerant from one of said evaporators into the condenser and creating a higher pressure within the condenser, said refrigerant being liquefied in the condenser, means for conducting and controlling the flow of liquid refrigerant to said evaporators, said means including separate means for restricting the flow of liquid to the low temperature evaporator, said conducting and controlling means including pumping means energized by the pressure energy of the liquid refrigerant for creating with the aid of the separate restricting means a lower evaporating pressure within the low temperature evaporator than in the high temperature evaporator.

12. Refrigerating apparatus including a plurality of evaporators adapted to contain a refrigerant, means for admitting liquid refrigerant to one of said evaporators, means for conducting liquid refrigerant from said one of said evaporators to another thereof, means separate from said first named means for controlling the flow of liquid refrigerant through said conducting means, said last named means being normally closed and actuated into open position automatically in response to the level of liquid refrigerant in said one of said evaporators, and means for withdrawing evaporated refrigerant from said evaporators and for supplying liquid refrigerant thereto and creating a substantially lower evaporating pressure and temperature in said another evaporator than in said one evaporator.

DON E. DASHER.